DOCUMENT RESUME

ED 439 946 SE 063 444

AUTHOR	Chin, Chi-Chin; Tuan, Hsiao-Lin
TITLE	Using Museum Setting To Enhance Pre-Service Science Teachers Reflect Their Student Teaching in a Methods Course.
PUB DATE	2000-04-29
NOTE	22p.; Paper presented at the Annual Meeting of the National Association for Research in Science Teaching (New Orleans, LA, April 28-May 1, 2000).
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Foreign Countries; Higher Education; *Methods Courses; *Museums; Preservice Teacher Education; *Preservice Teachers; Qualitative Research; Reflective Teaching; Science Instruction; Science Teachers; *Teaching Methods
IDENTIFIERS	Taiwan

ABSTRACT

The purpose of this study was to enhance the reflection of pre-service science teachers by infusing museum resources and context into a methods course. Qualitative methods were used for data collection from 21 students who took the course. The data sources came from field notes, reports, diaries, and interviews. The findings showed that when the methods course was infused with museum resources, it created a novice situation for pre-service science teachers to learn how to teach science. They reflected their practicing teaching in the museum context in the following four categories: (1) the way to use museum resources effectively; (2) the characteristics of science learning in the informal settings; (3) the enlightenment from peers' modeling teaching; and (4) the discrepancies between theory and practice in teaching science. According to their practices, they also showed some obstacles in dealing with teaching in the museum setting. Finally, this study made the suggestions for those teacher educators who would like to connect museum resources and context to nurture prospective teachers. (Author/CCM)

Reproductions supplied by EDRS are the best that can be made
from the original document.

ED 439 946

USING MUSEUM SETTING TO ENHANCE PRE-SERVICE SCIENCE TEACHERS REFLECT THEIR STUDENT TEACHING IN A METHODS COURSE

Chi-Chin Chin,
Tunghai University

and

Hsiao-lin Tuan,
National Changhua University of Education

Paper presented in the 2000 Annual Meeting of National Association for the Research in Science Teaching, New Orleans, LA, USA, April 28—May 1

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY
C Chin
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
1

BEST COPY AVAILABLE

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

SECO3944

USING MUSEUM SETTING TO ENHANCE PRE-SERVICE SCIENCE TEACHERS REFLECT THEIR STUDENT TEACHING IN A METHODS COURSE

Chi-Chin Chin,
Tunghai University and
Hsiao-lin Tuan,
National Changhua University of Education

ABSTRACT

The purpose of this study was to enhance the reflection of pre-service science teacher by infusing museum resources and context into a methods course. Qualitative methods were used for data collection from 21 students who took the course. The data sources came from field notes, reports, diaries, and interviews. The findings showed that methods course infused with museum resources has created a novice situation for pre-service science teachers to learn how to teach science. They reflected their practicing teaching in the museum context in the following four categories: 1) the way to use museum resources effectively, 2) the characteristics of science learning in the informal settings, 3) the enlightenment form peers' modeling teaching, and 4) the discrepancies between theory and practice in teaching science. According to their practices, they also showed some obstacles in dealing with teaching in museum setting. Finally, this study made the suggestions for those teacher educators who would like to connect museum resources and context to nurture prospective teachers.

Key words: Methods course, Museum education, Pre-service science teacher, Reflective practice.

OBJECTIVES OF THE STUDY

Methods course is an essential channel for pre-service teachers to prepare themselves efficiently and effectively for adapting with the real teaching context in the future. Pre-service teachers are usually oriented to experience the teaching context through a methods course with the systematical and meaningful syllabus. Always, the

syllabus of methods course is generally consisted of modeling teaching, school-site visit, classroom observation, micro-teaching, and reflection through the course.

The traditional methods courses for Taiwanese science teachers, without exception, are mainly focused on the learning activities developed for the environment of classroom and labs. The acquisition of out-of-school field experience from authentic nature and substitutive nature, i.e., science museum, has not been paid enough attention at pre-service science teacher program of Taiwan in the last decades.

Doubtlessly, the suggestion to connect teacher education with the informal settings is proposed as a brand-new issue in Taiwan on this moment. As reported by Chin & Tuan (1999), Taiwanese people were not provided with the structured museum education program to facilitate their learning in the museum context until 1975 when the first large-scale science museum—National Museum of Natural Science (NMNS)–was opened to the public. After this, the fact that museum played as a resource center in the community has been widely accepted in the Taiwanese society. After the opening, the number of visitors to NMNS is always exceeding 2 million each fiscal year. Over half of them are schoolteachers and students. Based on the composition of visitors, such issue that how to empower Taiwanese teacher eligible to utilize museum resources for instruction has emerged and become more essential for teacher educators to deal with than before.

Therefore, this study was designed to infuse the resources and context of science museum to a pre-service science teachers program for creating an encountering situation between the traditional and new paradigms of thinking in terms of the teacher education. By using such a circumstance, this article investigated the reflections of pre-service science teachers while they dealt with the museum resources and contexts.

Object Learning in the Museum Context

Museum is abundant with objects. Swift (1999) indicated objects could be used for all ages, abilities and cultural background. Learning happening within the museum environment needs direct contact objects involving all the senses. The social interactions are also spontaneously encouraged. Science museum is regarded as one of

the most suitable science learning context for its containing consensus, teaching models, objects, and text (Gilbert & Boulder, 1998). Prist and Gilbert (1994) also noted that students learned in the museums by interacting with each other, with teachers, parents, and adult helpers, with the display objects, and by relating experience to their prior experience. It is believed that museum context represents as a learning environment with playfulness and meaningfulness for students if schoolteacher organize the activity systematically.

Using Museum Resources in Methods Course

Ault and Herrick (1991) reported both learning and teaching of student teacher were improved in a teaching methods course integrated with evaluation studies of science museum exhibits. They reported that the role of informal learning, for pre-service teachers, was not just to achieve objectives of affective and conceptual change, but also to foster their ability in practice and responsibility for the teaching as a social activity. For promoting pre-service science teachers' awareness of community-based science education centers, Tirunarayanan (1997) developed an assignment in a methods course by involving pre-service teachers in the process of collecting information for the directory from various science education resource centers in their own community. The outcome showed pre-service teachers become more familiar with social resources potentially being used in their future lesson plans. These examples tell us the effort teacher educators have made to connect methods course with museum settings in the western countries.

RESEARCH DESIGN AND PROCEDURE

A methods course that was offered to pre-service science teachers in a comprehensive university in the central Taiwan provided the basis for the researcher, i.e., also the instructor for this class, to develop a syllabus infused with museum education experience. In this class, twenty-one pre-service science teachers attended. Among them, 7 students were from pure science majors (1 physics, 2 chemistry, 4 biology). Others (N=14) were applied science majors (5 animal science, 3 environmental science, 3 food science, and 3 chemical engineering). Two thirds of them

(N=15) were graduate students. In order to enhance the discussion between peers, these students were divided into eight homogeneous small groups based on the majors.

Although the development of museum-based activity was the most important part of this class, all students needed to know the purpose of this course, the nature of informal science education, the effective strategies used in the informal settings, and so on, before they started the work. Therefore, the syllabus (Table 1) was introduced in the very beginning of the class and three lectures covering the above backgrounds needed in the whole process was introduced to the students. After this, each group was requested to select a topic in the science textbook they would teach in the future to practice how to develop learning activity (Table 2).

Table 1. The Syllabus of the Methods Course

Week	Content
Week 1-3	• Introduction of rationale and Purpose of this course
Week 4-8	• To develop a lesson plan for classroom use • A visit arranged by the instructor
Week 9-10	• Lesson plans reviewed by other groups
Week 10-13	• To transform lesson plan to fit the museum context
Week 14	• Lesson plans reviewed by other groups
Week 15 -17	• To practice two selected lesson plans in the real context of museum
Week 18	• To retrospect the course

To help them develop with successful experience, the researcher requested these students start their lesson plans with what they would teach in the science classroom environment. Along the period for them to develop, there was also a special arranged field trip to the NMNS for students to explore the resources potentially being used in the following museum-based plan based on the same learning activity. In addition, they also arranged several informal visits to the NMNS for in-depth inquiries in such a setting. After they finished the first assignment and were equipped with the knowledge from the museum visit, then they set forth to modify their plans suitable for being used

in the museum context by adopting museum resources. Here, we might call this procedure "transformation of the plan".

Table 2: Topics Chosen for Developing Lesson Plans

Subject Area	Topic	Number of Group Members
Biology	Human and the Environment	2 Animal Science Students (A1, A2)
Biology	Ecosystem	2 Biology Student(B1, B2) and 1 Food Science Student(F1)
Biology	Coordination	3Animal Science Students (A3, A4, A5)
Biology	Reproduction	2 Biology Students (B3, B4)
Physics and Chemistry	Water	3 Environmental Science Students (E1, E2, E3)
Physics and Chemistry	Heat and Temperature	2 Chemistry Students (C1, C2)and 1 Chemistry Engineering Student (CE1)
Physics and Chemistry	Light	1 Physics student (P1), 2Chemical Engineering Students (CE2, CE3)
Physics and Chemistry	Sound	2 Food Science Students (F2, F3)

After their transformation was done, all paper work was distributed to peers for eliciting the comments. Based on the feedback, each group revised their own plans. Among eight developed plans, two of them, one named "water" developed by environmental science students and another named "human and the environment" developed by animal science majors were purposively selected to practice in the real context of the NMNS. Along the process of practice, their presentations were recorded by videotape. Peers were requested to do the observation and submitted their field notes to the lecturer.

Along the whole process of this course, instructor interviewed a food science major, a biology student, two chemical engineering majors and two animal science students. All data collected through the process included 1) lesson plans for being used in the classroom, 2) lesson plans adopting the museum resources, 3) peers' comments, 4) diaries written by pre-service teachers, 5) researcher's field notes, 6) interviews, and 7) video tapes on students' practicing in the museum setting. These qualitative data

were consistently compared along the collective process. The primitive assertions were generated according to the data already collected. While the more data gathered, they were checked with the previously obtained information, and decided if the primitive assertions would be kept or modified. The accountability of the findings was assured by providing the evidences from various sources. Besides, the author also tried to describe rich information about the context, which the event occurred in.

FINDINGS

According to data gathered from pre-service teachers in the process, they reflected their developing work and practice in the museum context in the following aspects:

1) Pre-service teachers become more acquainted with the museum resources applicable to science teaching after taking this course.

All pre-service teachers (N=21) claimed that they improved their knowledge about the museum resources after taking this course. A typical narrative was quoted as follows:

> *After visiting NMNS, our group members have learned more about how the museum resources were connected to school science lessons. We have more confidence on choosing appropriate museum resources to present the lesson we decide to develop. (D981118P1)*

Her group members agreed that the visit to the NMNS, which focused on the exploring the resources relevant to the topic they had chosen, improved their knowledge about the museum and strengthened their confidence on the following developing work.

Being interviewed, a chemical engineering major (CE2) illustrated some exhibits as instances to show how museum resources could be connected to the lesson she chose:

> *There are several exhibits useful for school teaching. For example, an exhibit in the fourth floor presents why people see the moon as full or wane condition. In the outdoor area, the sundial shows how people devised technology for their own needs. All of these can be combined with school lesson to teach students the reflection and*

refraction of light. Moreover, an interactive exhibit allows visitors to move the curtain and object. Therefore, people can learn the relationship of object and distance by actively involving in manipulating the variables. Such resources are useful for impressing them the characteristics of light. (INT981112CE2)

An animal science student (A1) shared with author what he acquired in collecting the worksheets published by the curators of the NMNS.

T: What did you do in developing your lesson plan?

S: Through this course, I have collected several educational resources.

T: Could you give an example?

S: I would like to illustrate that museum curators have developed several self-guided worksheets suitable for elementary and junior high students to use.

T: How did they help you develop the work?

S: The primary purpose was to use it in our lesson plan. However, after I went through these materials, I wonder why worksheets did not cover all topics in the NMNS. Therefore, it is not easy to adopt the existing one to our lesson plan.

T: So, how did you solve this problem?

S: I finally understood the museum had so many themes that this work could not be done thoroughly. But, the available worksheets gave me some ideas to develop my own. I guess what the already existing ones could be treated as the models for us to develop suitable ones fitting for our own teaching purpose.

T: what do you think a teacher needs if he or she plans to use the museum?

S: First of all, teachers need to improve their knowledge about the museum. But, most importantly, they should have ability in developing a new set or modifying existing ones to fit their own purpose. (INT981014A1)

According to his words, he noted that he was enlightened by the insight purpose of worksheets for a future teacher like him. The available resources provided him with good examples to follow in doing the work. He also knew what the rationale these worksheets were based on.

The above notes from pre-service teachers confirm that they gained acquaintance of the various sources in the NMNS applicable to their school science teaching.

2) Though involving in developing learning activities in the NMNS, most of pre-service science teachers start to realize the learning nature and suitable teaching strategies used in informal setting.

After several field observations in the NMNS, most of pre-service science teachers become to realize the difference between informal and formal learning setting. Former provides open-ended context, which causes different learning nature from classroom setting. After realizing the difference in how students learned in the above two contexts, the pre-service science teachers start to develop teaching strategies specially for enhancing students' learning in informal setting. Judged from their work, eight groups unanimously emphasized the importance of worksheet used in the museum context. Among them, six groups developed complete form of worksheet, another two groups, i.e., the groups that chose the topic "Heat and Temperature" and "Light", respectively, merely claimed they would use worksheet to help students learn in the museum environment in their lesson plan. But they did not provide the solid products, even any primitive form, for peer to review in the following session. Nonetheless, almost pre-service teachers achieved the consensus; at least verbal committed that worksheets were useful for students to follow a structured format to learn in an open-ended environment. In fact, such structured efforts also allowed an extent of freedom for students to decide their own pace and strategies to attain the common learning objectives. A female student (B2) commented the power of worksheet when interviewed.

T: What strategy would you like to use?

S: Our group plans to design worksheets.

T: Why do you decide to do so?

S: Teacher' guidance and explanation is not easy for a whole class. The exhibits or other simulation games will attract students.

T: What else?

S: If a teacher offers lecture in the exhibit hall, ordinary visitors will probably disturb the instruction. This makes the learning context difficult to control. Students could use worksheet as the basis to

learn something from the various resources in the museum. In finishing the worksheets, students have to work together to collect information, they can conduct brain storming with each other, and gain and clarify one's concepts. (INT981209B2)

Although most of groups designed worksheets in their lesson plans, their development obviously showed various orientations from the simplistic to elaborated forms. Even though two groups did not finish their worksheets, they mentioned that, in their group reports, the worksheet would be useful in integrating the activities in the museum.

Truly, five out of eight groups planned to use inquiry method accompanied with worksheets to help students engaging in small-group activities in the exhibit hall. These groups developed worksheets as the guideline for students to follow as they explored in the museum. Interestingly, the "water" group designed the complete form of worksheet, but they did not provide time for students to use it independently. The students were requested to fill the open-ended questions and blanks in the meanwhile they listened to pre-service teachers' demonstration and instruction in the exhibit hall. This was the only group that did not organize small group for student to work together.

Besides the worksheet, the information in Table 3 shows that pre-service teachers also used the teaching strategies such as teacher-guided viewing the exhibit hall, instruction in the theatre classroom, group inquiry in the exhibit hall, demonstration to the students, hands-on activities, post-visit discussion, role-play, note-taking, and composition writing. The groups focussing on biology topics did not use demonstration and hands-on activities. Three of them assigned students to write the composition after the visit, but only one out of four physics-chemistry groups did so. Only "coordination group" utilized role-play. Seven groups used post-visit discussion to summarize the instruction in the museum. "Reproduction group" was the only exception.

The evidence indicated that pre-service science teacher tried to apply flexible teaching methods instead of traditional lecture teaching methods to overcome the open-ended learning context in the NMNS.

Table 3: Teaching Strategies Used in the Lesson Plans Developed by Pre-service Teachers

Topic	Viewing the exhibits guided by teacher	Theatre classroom	Inquiry in the exhibit Hall	Demonstration	Hands-on activities	Taking notes	Post-visit composition	Post-activity discussion	Role-play
Human and the Environment	◎		◎			◎	◎	◎	
Ecosystem	◎		◎			◎		◎	
Coordination	◎					◎	◎	◎	◎
Reproduction		◎	◎			◎	◎		
Water	◎	◎		◎		◎		◎	
Heat and Temperature.	◎				◎	◎	◎	◎	
Light		◎	◎		◎	◎		◎	
Sound	◎	◎	◎	◎	◎	◎		◎	

3) Although most of pre-service science teachers appreciated the open-ended nature of museum setting, they usually concerned the management of students' learning activities.

Although many pre-service teachers noticed the open-ended nature of museum setting, when designing learning activities, they tended to use teaching strategies feasible to monitor students' learning and behaviors in the museum setting. For instance, many pre-service teachers described the teaching strategies they applied to museum setting were the use of group work, which not only provide students with opportunities to learn together, most importantly, it was easy to monitor students' behaviors.

> *There are many problems in transferring learning activity for the museum. For instance, how to manage and control the discipline, how to design the activities and how to lead learning activity are what I concern. Our group decides to use pre-visit explanation and then organize small groups for facilitating students' learning. In the end of the lesson, we will give them summary session to integrate the knowledge involved in the learning process. (D990106P1)*
>
> *Because museum belongs to an open-ended learning environment,*

BEST COPY AVAILABLE

therefore, it is difficult for teacher to monitor students' learning progress. How to control students' discipline is another concern. In our group we use worksheets, group work, assessment and combination kinds of activities to solve the above problems. (GR990120-7)

The above narrative revealed their common concerns on students' learning behaviors in the informal setting. That worry comes from their stereotype of the museum defined with less possible in using traditional strategies to control student's behaviors. In other words, to teach science in the classroom is more characterized as a closed system with higher degree of structured format than that in the museum. It is not unusual that pre-service teachers who experienced limited acquaintance of informal setting would judge museum context from the school perspective.

The "heat and the temperature" group revealed their worry in another aspect. They were not sure how to define teacher's role during the instruction in the museum.

We did not understand the role that the teacher should play while teaching in the museum context. (GR990112-6)

Till now, they did not achieved the answers to this question. Nonetheless, the suspicion of teacher's traditional role at least a start point to make a change. If a teacher would like to teach effectively in the museum, to know the teaching strategies and teacher's role are equally important.

4) Based on observation and discussion on the static exhibit, pre-service science teachers got to know the importance of elaborating a scientific conceptual framework about an individual exhibit.

Pre-service teachers should get acquainted with the museum resources if they want to develop appropriate learning activities in the museum context. Therefore, they especially concentrated on what the exhibits connected to school lessons they had chosen while visiting the NMNS. However, it is not enough if a teacher superficially memorizes the name or specific terms related to an exhibit. A teacher needs to empower his/herself with sufficient content knowledge for meaningfully representing the conceptual framework embedded in a specific exhibit during teaching in the museum. Thus, in order to design an appropriate learning activity in the museum, teachers should not only learn what kinds of the resources museum has, but also be

familiar with the "story" behind the scene. Although pre-service teachers' focus was mainly on what exhibits and educational activities museum could provide, some of them got to see the insight part of the static exhibit while they were doing the fundamental observations. For instance, a female pre-service teacher majored in food science (F1) mentioned she was embarrassed while making an attempt to explain the static exhibit to the students.

> *While I guided a small group of junior high students to see the zebra in the exhibit window, I stammered:*
>
> *"Look here, everybody. Um..., this is one of the most popular animals for all of us. I think you all know it is zebra."*
>
> *At that time, I thought everyone should know it and a specimen of zebra was just exhibited there, therefore, I did not need to explain much. But after the class, I retrospect what I told, and found there was something wrong. The explanation might be inadequate and inappropriate. I asked for help from my mentor (B1). He suggested me include more information related to the zebra such as its habits, physiological functions, its roles in the ecosystem of Africa, and the relationship between all of these factors. Moreover, he added:*
>
> *"You had better elaborate these information as a story while you explain it to the audience even though you are facing a static exhibit." (D990527F1)*

Another one (A2) also noted his change after experiencing in-depth observation on the static exhibit.

> *I used to consider the content of the exhibit while I observed an exhibit before. But now, I start to concern how the exhibits could be explained. (D9901209A2)*

Static exhibit is one of the most fundamental approaches to present the scientific framework to the visitors. Its steady state brings a broad scope for pre-service teachers to explore. If guided appropriately, they will see the in-depth ideas embedded in the exhibit. There are a lot of stories could be told based on the objects.

5) After experiencing the development and teaching practice in the museum context, most of the pre-service teachers become aware that the ability in integrating subject knowledge from various disciplines which dispersed in the individual exhibit areas by a systematic and logical way was important.

After visiting and working on the teaching assignments several times in the NMNS, most of the pre-service science teachers start to emphasize the importance of integrated science teaching. They guessed that a strategy should be developed for integrating the relevant resources dispersed in the different exhibit halls. After the discussion in the group, as mentioned in the previous section, they agreed to develop worksheet. But on the other hand, they also built their cognition on the rationale of integration while encountering various subject matters in each step of the development process. Over half of the pre-service teachers expressed they become to realize the importance of the strategy for integration if a teacher planned to adopt the museum resources into his or her regular science teaching.

> *In the process of transformation, I learned how to integrate different educational resources. Textbook is one kind of resource; museum is another one. How to integrate these two kinds of resources into a systematic knowledge is the ability that I have learned from this course. (D990113A1)*

> *After taking this course, finally I realize that I do not need to teach difficult subject knowledge to students. In fact, I should teach them the knowledge already integrated by me first. I remind myself to integrate all physical science curriculum to establish a systematical form of science knowledge or common sense by using events, and objects relevant to one's daily life. (D980930CE1)*

Since the curriculum development will be oriented to a new trend in the near future. Most of the pre-service proclaimed they needed help for adapting the coming changes. Especially, the subject that taught in the junior high level will be merged to seven broad learning areas. Among them, the subjects like biology, physics, chemistry, and earth science will become one area named "Nature and Daily-used Technology". The pre-service teachers attended to this methods course obviously earned the benefits because of the acquisition of ideas and strategy about the integrating science.

Biology and physical science have their own special exhibit area in the NMNS. Besides, there are a lot of exhibits presented as a theme, which go beyond the subject discipline, and belongs to integrated subjects. I think it fits the future curriculum trend. In fact, integrated science teaching is not only the future education trend, but also an efficient way to use all the resources together (D981014P1)

An environmental science student (E1) mentioned the resources relevant to biology area were useful in not only broadening students' interesting scope, but also empowering a prospective teacher like her by expanding subject matters other than what one was originally trained.

I found the museum could provide us diverse learning context. In addition, museum could provide us extra curriculum resources, such as information about ecology and life science. If we use museum context to teach science, we can combine other subjects together into teaching, such as earth science, biology, etc. (D981021E1)

In developing lesson plan infused with museum resources, I realized that the unit in the NMNS was independent from each other in terms of space. However, when a teacher plans to use resources from the NMNS, he/she has to unify the independent units together for helping students build a systematic conceptual framework. All the scientific subjects such as biology, physical science, earth science, and so on can use museum contexts to attain their teaching objectives through integrating strategy. (D981230C1)

Here, the report written by "sound group" could be illustrated as an example to show how pre-service teachers developed their lessons by adopting diverse aspects of museum resources (Table 4). In their paper work, four major parts from the areas were included. First one was scientific demonstration that utilized the instruments and experimental design developed by curators to show the nature of sound and how it worked. Second part was to see the drama and attend role play to experience the functions of sound produced by animals in the natural world such as communication, warning, defending the territory, asking for help, courting, acting as weapons, and pretending. Thirdly, a guided visit to the exhibits relevant to sound was arranged. Finally, theatre classroom presenting the topic "Keep silent" was included to help students understand what the differences between the music and the noise, the techniques developed by engineers to prevent noise, and the strategy to nurturing

citizens' positive attitudes and behaviors about keep the environment genial.

Table 4. An Example of Lesson Plan Used in the Museum Context

Teaching Procedure	Teaching Objectives	Assessmen	Time
A. Stimulate motivation 1. Assign each four students to form a learning group 2. Distribute the worksheet to each student and explain the assessment criteria to them 3. Explain the purpose of the questions in the worksheet, and suggest them the areas could find the answers 4. Describe the relevant content to the visit			15min
B. Visiting procedure 1. Observing Scientific Demonstration—Jumping Music	1. Using spring, sonic boom, and oscillator to show students what sound is. 2. Swallowing chemicals in the throat to change human voice 3. Sound element—loudness, tone, and timbre of a sound 4. How sound is generated, how it changes and transmits 5. Resonance and vibration 6. What is supersonic?	Students fill out the worksheet	20min
2. Watching Sound Theatre	1. The sound or voice from human world 2. The functions of sounds in the animal world—communication, warning, defending the territory, asking for help, courting, acting as weapons, and pretending.	Students fill out the worksheet	20min
3. A Visit to Exhibit Area—Sound in the Natural World	1. To know how different animals produce sounds, and what their auditory organs. Eg. Rattle snake, tiger, bat, etc. 2. To learn the meaning of the sounds produced by different animals 3. To identify the sounds produced from different animals in playing "recognizing objects according to the sounds 4. To play different instruments, and observe what differences occur between them	Judge the extent that group members co-operate together	30min
4. A Visit to Science Center in the NMNS oscillator Transverse wave and longitudinal wave Communicator with parabola surface	1. To observe the sound wave from different students, and find out each has unique timbre 2. To observe the relationship between the tone and the speed wave transfers 3. To understand the principle of communication with parabola surface and its application	Judge the extent that group members co-operate together	30min
5. Listening to the explanation in the science theatre—Keep whisper!	1. To inquire the issues of noise in daily life 2. To find the way to preventing from the noise 3. To nurture students' concern about the nature world	Judge the extent that group members co-operate together	30min

BEST COPY AVAILABLE

C. Sharing with peers 1.Students gather together, and collect the filled worksheets 2.To ask students questions related to worksheet 3.Let students discuss and comment the questions they propose	To .impress on students after they observe the NMNS 2.foster students' problem-solving ability 3.To facilitate students' collaborative ability		40min

(GR981212-8)

6) Inter- and intra-group discussion and peer evaluation facilitated pre-service teachers to reflect what they have done in developing their lesson plans.

Cooperative learning and peer evaluations were incorporated into the syllabus of the course. Thus pre-service teachers have to work within groups and discuss with group members about their lesson plans and teaching outcome. In addition, each group has to provide comments on the work of other groups. These features embedded in the methods course created a sound learning environment for the pre-service science teachers to observe various teaching strategies and ways to representing concepts from other groups.

> *After peer reviewing process, I found the works made by some groups were very creative. Especially what biology groups did could be as good models for us to follow. Besides, we also obtained the comments from other groups. After digesting the suggestions, we decided to adopt some everyday issues to make our topic interesting, and design some experiments to lead students' learning. Peer review enlightened me revised lesson plan in a holistic way and added multiple strategies to assess the learning effectiveness of student. (INT981209CE1)*

> *All the teaching activities designed by different groups are unique...Their ways in conducting teaching activities could help us design our unit. In addition, many evaluation strategies embedded into the teaching activities are useful in designing our multiple assessment. (D980120P1)*

Peers not only mentioned the strength of lesson plan, but also indicated what needed to change. And pre-service teachers responded these comments in their diaries and actual correction in the lesson plans.

> *According to the suggestions from other groups, they commented I*

BEST COPY AVAILABLE

put too much information into my lesson plan. I need to learn how to elaborate information concisely and efficiently. (990113A4)

The peers in other groups commented that our instruction used for the museum context was too simple. To tell the truth, we really did not realize the exact way to write the lesson plan while we were doing the work. However, after reviewing the paper work from others, we guess what wrong was in ours and got the right direction to revise it. (GR990112-6)

Some appreciated the social interaction created both within and between groups.

After observing the exhibits and discussing with peers, I become to realize it was so important to provide a process of social construction for us to learn. (D991209A2)

After experiencing idea-sharing process and the emulation from the presentation by others, pre-service teachers were encouraged to adopt co-operative learning. Table 5 shows how pre-service teachers perceived the effectiveness of personal and group working together in this course. Although there was no significant difference found between personal and group basis while judging all six items, we at least found out that they have rated group performance higher than what was done by the individual. From the data shown in Table 5, the first two prominent statements they expressed were 1) their strong motivation in working together, and 2) their intention to sharing ideas with peers.

In general, comments stimulated consequent thinking process of pre-service teachers. Some helped them make the revisions. However, some else, but not too many, created a contradictory condition since it was not unusual that peers judged the same thing from opposite direction.

The comments from the peers are so diverse. Some of them suggested oppositely. Some revealed their misunderstanding on our thought. Maybe it is partly because that we did not communicate our thought clearly. But I was confused on the totally different positions toward our device. (INT990115CE1)

Facing such a controversial situation, they lost the state of equilibrium. However, it is at least a factor to stimulate pre-service teachers to speculate more thoroughly.

Table 5: The Frequency Distribution of How Pre-service Teachers Percept Their Own and Their Group Members Work in the Small Group Basis

Statistical Methods / The Statements		Frequency Distribution(N=19) 5 4 3 2 1	Mean± Standard deviation	Rank
Mastery of learning objectives	P	4 11 4	4.00±0.67	3
	G	7 11 1	4.32±0.58	(4)
Mastery of learning content	P	5 9 5	4.00±0.75	4
	G	9 8 2	4.37±0.68	(2)
Sharing with peers during discussion	P	8 7 4	4.21±0.79	2
	G	9 8 2	4.37±0.68	(2)
Collecting appropriate information	P	2 13 3 1	3.84±0.68	5
	G	6 11 1 1	4.16±0.76	(6)
Using information in a appropriate way	P	3 10 5 1	3.79±0.78	6
	G	8 8 3	4.26±0.73	(5)
With strong motivation to work with group members	P	7 10 2	4.26±0.67	1
	G	12 6 1	4.58±0.61	(1)

Note: P—Personal basis, G—Group basis

DISCUSSION AND CONCLUSION

Based on the previous findings, it is indicated that using museum context to teach school science has their strength and limitations. For the strength part, pre-service science teachers quickly distinguish the different learning features between museum setting and classroom setting. Therefore, they need to design appropriate teaching methods flexibly to adapt with the different teaching contexts. They gain awareness of how different learning environment influence students' learning and teachers' teaching. These kinds of awareness can not be easily taught in traditional methods course.

Pre-service science teachers have changed their role from simply acting as a ordinary visitors to becoming a purposive observer for further being as a producer who carefully select what could be connected with their science regular science lessons from the museum setting. This kind of role change, made teachers not only learn the science

concepts embedded in the exhibit but also learn the representation of the concepts to teaching. Based on our course design, pre-service science teachers learn concept representation from the course.

Another benefit of using museum setting in enhancing pre-service science teachers' thinking of teaching is their integration ability through collecting various museum resources. This kind of awareness is not the same as traditional teaching. In the later, many science teaching tried to organize what concepts have been covered in the textbook into a systematic way in teaching. However, the former, when teacher faced the museum teaching context, they start to collect many resources, and then integrated concepts or contexts in order to teach students in a systematic way. The different teaching context could help teacher adjust their previous schema of teaching and used novice way in organizing science teaching.

The other benefit of using museum setting into teaching is that pre-service teachers were quickly aware of the importance in applying multiple ways to assess students' learning outcome. They could not only rely on paper-pencil test; instead they need to design other ways to assess students' learning within the museum setting and also in the classroom setting. Without changing teaching context, pre-service science teacher could not feel the needs in learning various ways of assessment strategies.

Of course, there are also limitations by using museum setting into teaching science. For instance, in the NMNS it is easy to teach biology subject than physical science subjects. There is difficulty to teach all the topics from the science textbooks in the museum setting. Therefore, how to help pre-service science teachers to find the maximize benefit in applying museum setting into their future teaching and also into pre-service teacher education program need to be considered.

From this course, we also find some common perceptions among the group of pre-service science teachers. One of the concerns is that the teachers still worried about how to control and manage students' learning and their behaviors in the museum setting. Finally, they achieve the consensus to design worksheets and groups work for students to work together in museum setting. The teaching strategies they chose naturally led them to consider the effectiveness of student-centered learning activity. Interestingly,

they can not but use the teaching strategies with the spirit of independent study, since the methods course requested the adoption of museum setting into the regular science teaching.

Another common perception is that multiple assessment methods were required in the developed lesson plans. Peer evaluation set in this course provided pre-service teachers with opportunities in emulating various ways to assessing students' performance. However, they also found the difficulty in setting the criteria for judging student responses since most of the information gathered for assessment was qualitative data. Nonetheless, we found that these considerations originated from museum setting are very good which would force pre-service science teachers learn from each other, and also broader their teaching strategies and representation ability.

References

Ault, C. R. & Herrick, J. (1991). Integrating teacher education about science learning with evaluation studies of science museum exhibits. Journal of Science Teacher Education, 2(4), 101-105.

Chin, C.C. & Tuan, H.L. (1999). What Changes Occurred? —An In-service Course Focused on Museum Education for Taiwanese Science Teachers. Paper presented at the Annual meeting and Conference for the National Association of Research in Science Teaching in Boston, March 28-31,1999.

Gilbert, J.K. & Boulder,C.J.(1998). Learning science through models and modeling. In Tobin,K.(ed.):International Handbook of Science Education, Hingham, M.A., U.S.A.: Kluwer Academic Publishers.

Prist,M. & Gilbert,J.K. (1994). Learning in museums: situated cognition in practice. Journal of education in Museums,15,16-18.

Swift, F. (1999). Learning from objects. Museum Practice, 4(1), 55-56.

Tirunarayanan, M.O. (1997). Promoting pre-service science teachers' awareness of community-based science education resource centers. Journal of Science Teacher Education, 8(1), 69-75.